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CONVERSION TABLES FOR USE WITH THE NATIONAL FIRE-DANGER RATING SYSTEM IN THE INTERMOUNTAIN AREA

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ABSTRACT

Two tables prepared for use with the National Fire-Danger Rating System replace 10 tables previously used with the Model-8 Fire-Danger Rating System. They provide for the conversion of Spread Index values at various altitudes, aspects, and times of day. A rate of spread table facilitates converting Spread Index values to chains per hour of perimeter increase for various fuel types and slope steepness.

J. S. Barrows' publication on fire behavior in Northern Rocky Mountain forests¹ was a major contribution to better understanding of forest fire behavior. It included tables for predicting spread rate of fires and for conversion of Burning Index values at various altitudes, aspects, and times of day. The text and accompanying tables (A-8

¹ Fire behavior in northern Rocky Mountain forests. Northern Rocky Mountain Forest and Range Expt. Sta. Paper 29, 103 pp., illus. 1951. (Out of print)

through A-16) were designed to be used with the Model-6 Fire-Danger Rating System and were subsequently used with the Intermountain Model-8 Fire-Danger Rating System. George Fahnestock prepared instructions for use of these tables and added tables A-17 through A-19 for conversion of Burning Indexes.²

Adoption of the National Fire-Danger Rating System in Forest Service Regions 1 and 4 and discontinuance of the Model-8 System necessitated the preparation and adoption of new tables. The three tables printed here provide conversions for altitude, aspect, and time of day as well as relative rate of spread for various fuel types and classes of slope steepness.

Tables 1 and 2 provide conversion factors for the calculated Spread Index to adjust for different altitudes, aspects, and times of day. These two tables replace Barrows' tables A-8 through A-15 and Fahnestock's tables A-17 through A-19, respectively. Table 1 lists conversion factors for Spread Indexes obtained at "valley bottom" stations when projected to locations in the "lower 1/3 slope," the "thermal belt or middle 1/3 slope," and the "upper 1/3 slope." Table 2 lists conversions for Spread Indexes obtained at "mountaintop" stations when projected downward to locations in the "upper 1/3 slope," the "thermal belt," and the "lower 1/3 slope."

The provision in Barrows' and Fahnestock's tables for projecting conversions for longer than an 8-hour period each hour of the day has been discontinued. Spread Index calculations revealed differences in hourly changes to be insignificant and that conversions based on a 4-hour period extended for a 12-hour span would be adequate. This 12-hour projection was selected as being the maximum necessary to assist in fire control planning. For periods longer than 12 hours, the daily fire-weather forecast or a current fire-weather observation can be the basis for a revised, up-to-date conversion. The revised tables were also limited to the 0800, 1000, 1200, 1400, 1600, and 1800 observation times. Spread Index calculations indicated the conversions made at more frequent or additional observation times were insignificant and served only to complicate the tables. All calculations for Spread Index conversions were made from the original data of G. Lloyd Hayes³ as Barrows and Fahnestock had done for the Burning Index conversions.

² Correction of Burning Index for the effects of altitude, aspect, and time of day. Northern Rocky Mountain Forest and Range Expt. Sta. Res. Note 100, 4 pp. 1951. (Out of print)

³ Influence of altitude and aspect on daily variations in factors of forest-fire danger. U.S. Dept. Agr. Cir. 591, 39 pp., illus. 1941.

Table 1. --Spread Index conversions from valley bottom station to other altitudes, aspects, and times of day

Slope position	Time of observation	Conversion factor for projected time and aspect ¹							
		0 hrs.		4 hrs.		8 hrs.		12 hrs.	
		N	S	N	S	N	S	N	S
Lower 1/3 slope	0800	-5	+5	+10	+21	+8	+23	+4	+10
	1000	-5	+7	-1	+9	-6	+2	-11	-5
	1200	-7	+4	-9	+6	-13	-7	-19	-13
	1400	-5	+5	-10	-2	-15	-9	-18	-13
	1600	-8	+7	-12	-6	-18	-13	-21	-16
	1800	-2	+6	-7	-1	-10	-5	-13	-8
Thermal belt	0800	+1	+9	+7	+21	+8	+17	+7	+7
	1000	-8	+7	-4	+9	-5	0	-8	-5
	1200	-10	+4	-9	0	-10	-10	-13	-10
	1400	-8	+5	-9	-4	-12	-9	-12	-9
	1600	-8	+1	-9	-9	-12	-9	-12	-12
	1800	-1	+4	-4	-1	-4	-1	-7	-1
Upper 1/3 slope	0800	+7	+9	+11	+14	+15	+15	+7	+9
	1000	-3	-1	+3	+7	0	0	-5	-3
	1200	-6	-3	-2	-2	-10	-8	-10	-8
	1400	-1	+3	-4	-4	-9	-7	-9	-7
	1600	-1	-1	-9	-7	-9	-7	-12	-7
	1800	+4	+4	-1	+1	-1	+1	-5	-3

¹Spread Index will vary as indicated 0, 4, 8, and 12 hours after observation time. For East aspect conversions use North column and for West aspects use South column.

Instructions:

1. Select time of Spread Index measurement in valley bottom.
2. To estimate Spread Index at another location at the same time measurement is taken, read conversion for proper aspect in 0 hour column.

Example: At 0800, Spread Index in valley bottom is 38. At the same time the estimated Spread Index on the upper 1/3 south slope is 38+9 or 47.

3. To estimate Spread Index for a given number of hours at another location, read conversion for proper aspect in column showing length of estimate in hours.

Example: At 1200, Spread Index in valley bottom is 49. Spread Index 8 hours later on the lower 1/3 south slope is 49-7 or 42.

Table 2.--Spread Index conversions from mountaintop station to other altitudes, aspects, and times of day

Slope position	Time of observation	Conversion factor for projected time and aspect ¹							
		0 hrs.		4 hrs.		8 hrs.		12 hrs.	
		N	S	N	S	N	S	N	S
Upper 1/3 slope	0800	0	+2	+4	+7	+8	+8	0	+2
	1000	0	+2	+6	+10	+3	+3	-2	0
	1200	0	+3	+4	+4	-4	-2	-4	-2
	1400	0	+4	-3	-3	-8	-6	-8	-6
	1600	0	0	-8	-6	-8	-6	-11	-6
	1800	0	0	-5	-3	-5	-3	-9	-7
Thermal belt	0800	-6	+2	0	+14	+1	+10	0	0
	1000	-5	+10	-1	+12	-2	+3	-5	-2
	1200	-4	+10	-3	+6	-4	-4	-7	-4
	1400	-7	+6	-8	-3	-11	-8	-11	-8
	1600	-7	+2	-8	-8	-11	-8	-11	-11
	1800	-5	0	-8	-5	-8	-5	-11	-5
Lower 1/3 slope	0800	-12	-2	+3	+14	+1	+16	-3	+3
	1000	-2	+10	+2	+12	-3	+5	-8	-2
	1200	-1	+10	-3	+12	-7	-1	-13	-7
	1400	-4	+6	-9	-1	-14	-8	-17	-12
	1600	-7	+8	-11	-5	-17	-11	-20	-15
	1800	-6	+2	-11	-5	-14	-9	-17	-12

¹ Spread Index will vary as indicated 0, 4, 8, and 12 hours after observation time. For East aspect conversions use North column and for West aspects use South column.

Instructions:

1. Select time of Spread Index measurement on mountaintop.
2. To estimate Spread Index at another location at same time measurement is taken, read conversion for proper aspect in 0 hour column.

Example: At 0800, Spread Index at mountaintop is 24. At the same time the estimated Spread Index on the lower south slope is 24-2 or 22.

3. To estimate Spread Index for a given number of hours later at another location, read conversion for proper aspect in column showing length of estimate in hours.

Example: At 1200, Spread Index at mountaintop is 38. The Spread Index 8 hours later on the south thermal belt aspect will be 38-4 or 34.

A revised spread table (table 3) for converting Spread Index values to perimeter increase in chains per hour by fuel type and slope steepness was also prepared. The basic data for Barrows' table A-16 are still the only available data on rate of spread for this area. The entry into table A-16 was partially controlled by the current, projected, or predicted Burning Index; therefore, the entry values had to be shifted to agree with the relations of the National Spread Index to the Model-8 Burning Index. The National Spread Index was divided into 10 classes to correspond to the Burning Index groupings, e.g., 1-10, 11-20, ... 91-100. The midpoints of these groups were then used to obtain the adjusted numbers for entry in table 3. This kind of transformation made it possible to continue using the existing rate of spread data in terms of the National System. Additional studies are needed to verify Spread Index conversions and rates of fire spread.

The three tables in this paper should provide the working tools necessary for altitude and aspect conversions as well as for predictions for rates of fire spread. The values given in the tables should be interpreted as being relative rather than absolute. These tables can be a valuable guide for consistent dispatching, intelligent planning, and other fire control operations.

Table 3.--Average initial rate of spread¹ according to fuel type, slope steepness, and spread index at site of fire²

Fuel rate of spread type	Slope steepness ³	Spread Index									
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Low	Percent	- - - - - Perimeter increase (chains per hour) - - - - -									
	0-10	0	1	1	1	2	2	2	3	3	4
	11-25	1	1	1	2	2	3	3	4	5	6
	26-50	1	2	2	3	3	4	4	5	6	9
	51-75	2	3	3	4	5	6	6	8	10	14
	Over 75	3	4	5	6	7	8	9	12	16	21
Medium	0-10	1	1	1	2	2	2	3	3	4	5
	11-25	1	1	2	2	3	3	4	5	6	7
	26-50	2	2	3	3	4	5	6	7	8	11
	51-75	3	3	4	5	6	7	8	11	13	17
	Over 75	4	5	6	8	9	11	14	17	21	27
High	0-10	1	2	3	4	5	6	7	8	10	13
	11-25	1	3	4	6	7	8	10	12	14	18
	26-50	2	4	6	8	9	11	14	16	20	25
	51-75	3	6	9	12	15	18	22	26	30	40
	Over 75	6	10	15	19	24	28	35	42	49	63
Extreme	0-10	3	4	5	6	7	9	12	14	17	20
	11-25	4	6	7	9	10	13	17	20	23	28
	26-50	6	8	10	12	15	19	23	28	33	40
	51-75	9	11	16	19	23	30	36	44	53	62
	Over 75	16	20	25	30	37	46	58	71	84	97
Flash	0-10	6	12	15	18	23	28	33	40	50	61
	11-25	8	18	21	26	32	39	48	58	69	84
	26-50	11	25	30	37	45	55	67	81	97	119
	51-75	18	39	48	58	71	88	106	128	155	188
	Over 75	29	62	75	92	113	138	168	202	244	300

¹Average initial rate of spread refers to perimeter increase between discovery of fire and first attack. This rate of spread may be anticipated during the first 4 to 5 hours.

²This table was based on table A-16, NRM Station Paper No. 29, "Fire Behavior," by J. S. Barrows.

³General designations used in classifying slope descriptions (column 2) are: Level, 0-10 percent; Gentle, 11-25 percent; Moderate, 26-50 percent; Steep, 51-75 percent; Very Steep, over 75 percent.